Soil morphology and geochemistry in unglaciated west-central Yukon landscapes: case studies from the Lone Star, Lucky Joe and Clip properties

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Introduction

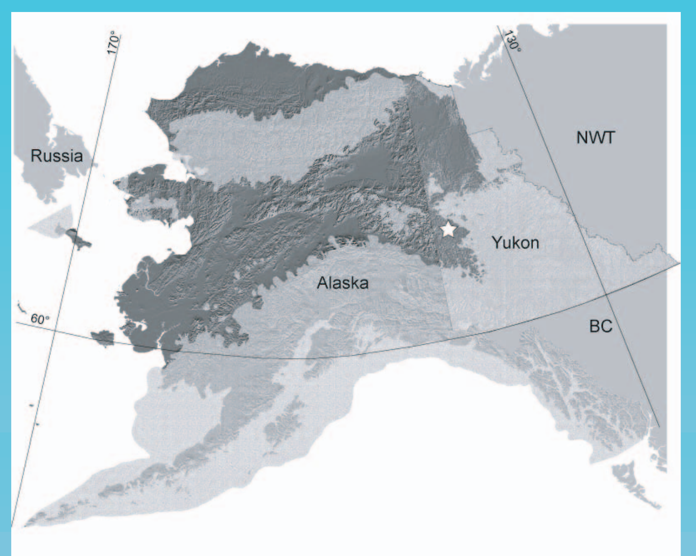


Figure 1: A map of northwestern North America showing the limit of maximum Pleistocene glaciation (light grey) and unglaciated regions (dark grey).

Large areas of northwestern North America remained unglaciated during the Pleistocene (Fig. 1) and are underlain by weathered bedrock (regolith) and locally a veneer of loess. Little is known about the character of soils that have formed in the regolith or how elements in these soils may be affected by geomorphological processes.

A soil study was undertaken in the unglaciated regions of west-central Yukon to characterize the distribution of economically important elements in regolith-derived soils (Fig. 2). The goal was to better understand the geochemical patterns associated with these soils and thereby provide guidelines for mineral exploration programs that utilize soil geochemistry in the unglaciated areas of northwestern North America.

This poster presents preliminary results.

Study Area

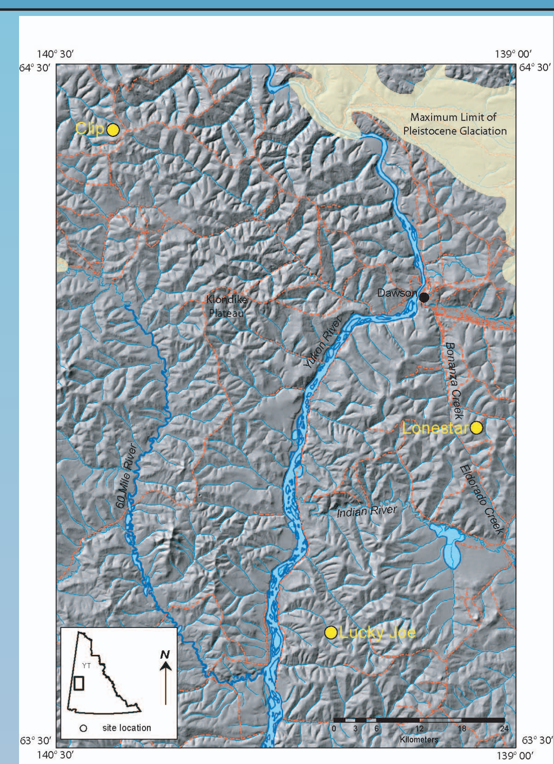


Figure 2: Location map showing the greater study area, mineral properties and the maximum limit of Pleistocene glaciation.

Soils were investigated at three different mineral deposit types to assess the geochemical patterns associated with different elements of economic interest (Fig. 2):
1.) Lone Star - orogenic Au vein;
2.) Clip - SEDEX (Pb/Zn);
3.) Lucky Joe - alkalic Porphyry Cu.

Methods

Figure 3: Hand pit dug on the Lucky Joe property.

Figure 4: Soil profile exposed on the wall of an old trench on the Lone Star Property near Dawson City.

To thoroughly describe the soils at these properties, soil profiles were studied on both warm and cold aspects. Exploration trenches were utilized where available to access the soils. Otherwise, exposures were created using hand tools (Fig. 3 and 4).

From each exposure soil horizons were identified and their colour, texture, thickness and associated contacts were described. Soil horizon nomenclature and soil classification terminology are based on those developed by the Soil Classification Working Group (1998). Samples from each horizon were taken for analyses of soil properties, particle-size and geochemistry. The soil property analyses were completed at the British Columbia Ministry of Forests lab in Victoria, BC. Soil particle size analyses was completed by Soilcon Laboratories, Richmond BC and the soil geochemistry were completed by Acme Analytical in Vancouver, BC.

For comparison purposes geochemical analyses was completed on three size fractions using ICP mass spectrometry following aqua regia digestion on 30g.

Fractions:
1. Crush: Representative pebble fraction plus fines crushed in a ceramic pulverizer to -100 mesh.

2. -80 mesh of matrix fraction

3. -230 mesh of matrix fraction

Lone Star

The Lone Star property is located in the Klondike goldfields south of Dawson City (Fig. 2). Soil properties were investigated in the Boulder Lode (north-facing aspect) and the Buckland zones (south-facing aspect). The mineralization at each site occurs in discordant quartz veins within Permian quartz muscovite schist of the Klondike Series (Cranswick et al., 1995). The geochemistry results from a composite crush, -80 mesh and -230 mesh for the Buckland zone are presented below.

Results

Buckland 2

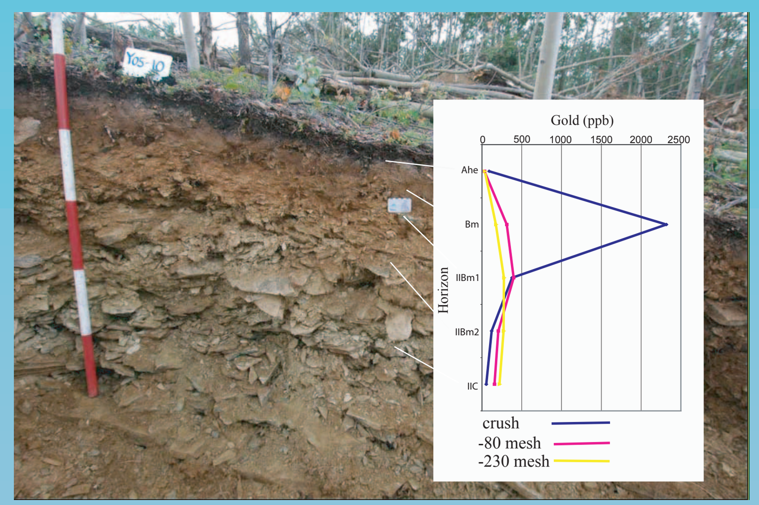


Figure 5: Buckland 2 exposure with gold geochemistry from each soil horizon of a Dystric Brunisol.

The Buckland 2 site is located about 20 m downslope from gold in quartz-vein mineralization. Gold values are generally enriched in the B-horizons relative to the C-horizon, for the analyses of the composite crush from the Bm horizon (mixed loess and colluvially transported regolith). Quartz vein clasts observed in Bm horizon probably resulted in the nugget effect in the crush component.

With the exception of the Bm anomaly in the crush component the -80 mesh fraction gave the highest gold concentrations.

The B-horizons, which consist of transported regolith (colluvium), contain higher gold values than C-horizon material because the colluvium contains mineralized bedrock from up-slope is shedding material into the colluvium.

Buckland 1

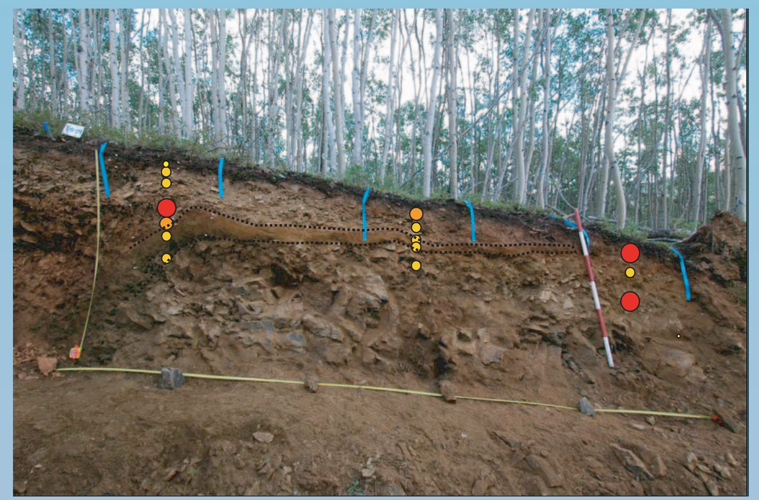


Figure 6: Distribution of gold in the composite crush fraction at Buckland 1. Soil is a Dystric Brunisol.

The downslope dispersion of a weathered Eocene mafic dyke is evident from this exposure at Buckland 1 (see dotted line; Fig. 6). The dyke was altered by an adjacent quartz vein that was weakly anomalous in gold. Incorporation of the weathered dyke material into the colluvial layer (upper B-horizons) occurs over 3-5 metres on this 14° slope. The dispersion of gold is also evident from the far left through to the top of the exposure at center.

As material moves down warm aspect slopes, the colluvium builds into semi-distinct stacked layers within the B-horizons of the soil profile.

Anomalous metal concentrations relating to distinct bedrock lithologies is mappable within the colluvium, although downslope dilution is evident.

Lucky Joe

Two soil pits on opposite-facing exposures were investigated at the Bear Cub zone on the Lucky Joe property, located 50 km south of Dawson City (Fig. 2). This area is underlain by a muscovite schist belonging to Yukon Tanana Terrane.

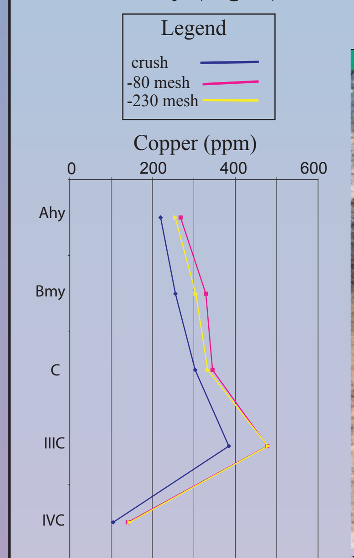


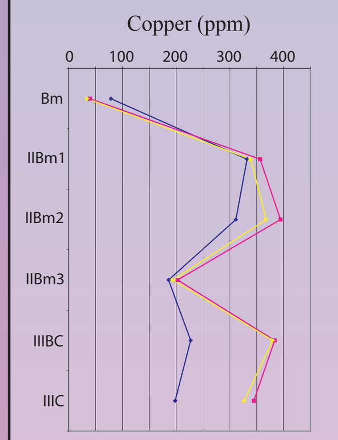
Fig. 7: Turbic Cryosol from the north-facing slope aspect on the Bear Cub zone at the Lucky Joe property.

Results

Two soil pits on the Bear Cub zone exemplified the influence of slope aspect on soil geochemistry.

The soil profile on the north-facing aspect has a 60 cm thick colluvial component, which typifies permafrost affected soils that have saturated active layers (Fig. 7). The colluvium, which consists of horizons Ahy, Bmy, C and IIIC, is composed of loess (that decreases with depth), transported regolith and stringers of organic material.

The soil on the south-facing aspect has a thinner colluvial layer (~35cm) with a more distinct separation between the loess and the transported regolith (Fig. 8).



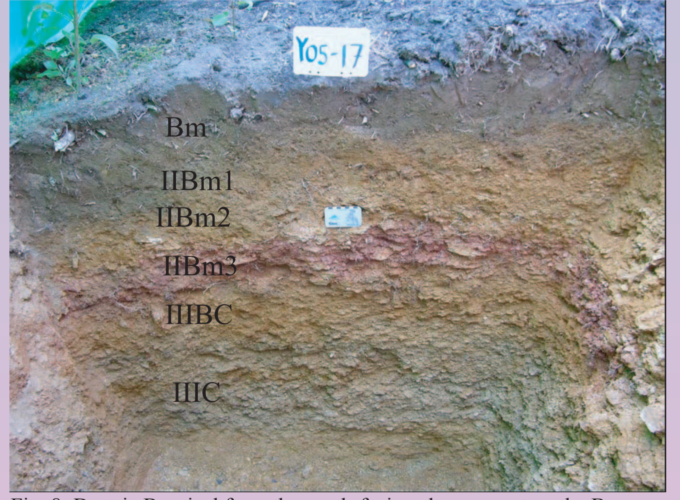


Fig. 8: Dystric Brunisol from the south-facing slope aspect on the Bear Cub zone at the Lucky Joe property.

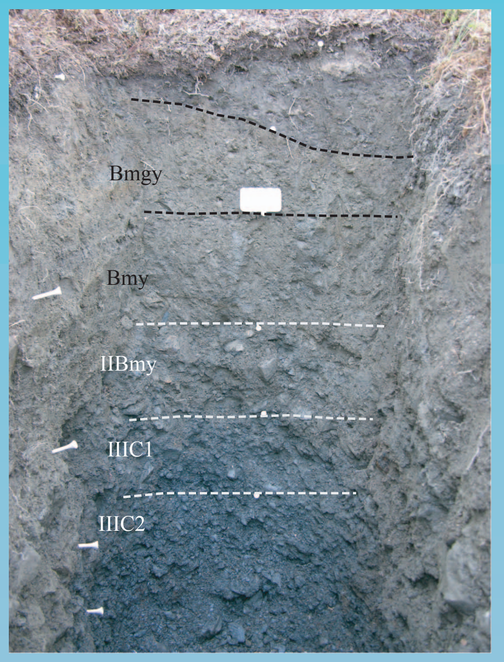
The degree of mixing of loess into the upper soil horizons is affected by the aspect of the slope and the presence of permafrost. On north-facing aspects where permafrost is present active layer cryoturbation and downslope colluviation mixes loess deeper into the soil profile. This causes a dilution of the geochemistry that is apparent in the results for copper (Fig. 7).

The opposite is true for south-facing aspects where permafrost is absent. The loess cap is more intact and less mixing of the loess has occurred with the transported regolith-based horizons. This results in very low copper concentrations in the Bm horizon, which is mainly loess, and consistent copper concentrations below the Bm horizon (Fig. 8).

Clip

The Clip property is located west of Dawson City (Fig. 2). The property is underlain by metasedimentary rocks of the Nasina series in the Yukon Tanana Terrane. Mineralization occurs as thinly banded sphalerite, galena, barite and minor pyrite in quartzite (Schmidt, 1996). Results from the soil pit located on the north-facing exposure are displayed below in Figure 9. The soil is classified as a Dystric Brunisol but the pattern of soil horizons indicates that cryoturbation has occurred, which suggests the former presence of permafrost. The well-mixed loess and regolith component is indicative of the former permafrost effects.

A)



B)

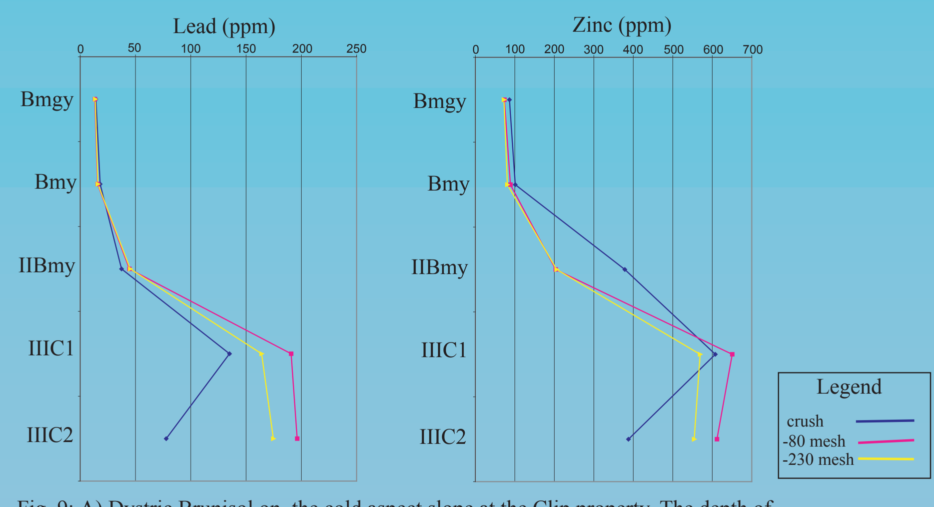


Fig. 9: A) Dystric Brunisol on the cold aspect slope at the Clip property. The depth of loess mixing is evident by the buff colour that extends down into the IIBmy horizon. B) The geochemistry of lead and zinc from the soil horizons.

Results

The geochemical profiles for each of the crush, -80 mesh and -230 mesh have a similar pattern. C-horizon values for Pb and Zn clearly higher than B-horizon values, because B horizon material contains reworked loess. The highest values were obtained from the IIIC1 for both lead and zinc.

Discussion

The loess content of the B-horizons is likely responsible for their diluted geochemistry. The gradual reduction in loess content with depth is reflected by the slight increase in Pb and Zn values with depth through the B-horizons. The B-horizon material consists of colluvium derived from up-slope.

Recommendations for soil geochemistry sampling in unglaciated areas of west-central Yukon

1. The geochemistry of regolith-based soils in unglaciated areas of west-central Yukon is affected by variations in the character of loess and regolith-based colluvium on hill slopes. The nature of the colluvium is determined by bedrock, slope aspect and the presence or absence of permafrost processes.

2. A preliminary assessment of the effects of weathering on soil geochemistry suggests that geomorphological processes like cryoturbation and colliviation may play a more important role in the element distribution patterns than actual soil weathering processes. This is largely because continuous hillslope transport of regolith keeps the soils relatively youthful and minimizes soil weathering effects.

3. Soil geochemical data that straddle cold (north and east-facing) and warm (south and west-facing) aspect slopes should be compared with some caution. Cold aspect slopes are more likely affected by permafrost, which causes increased colluviation and greater mixing of the upper colluvial-based horizons. The presence of loess to greater depths results in geochemical dilution relative to more stable warm aspect slopes with clearer horizon stratification and non-muted geochemistry below the loess.

4. Despite having a higher loess content than C-horizon material, samples from the lower B-horizon on warm aspect slopes should be targeted for low density reconnaissance soil sampling programs, because they are representative of a greater area of colluvial dispersion than C-horizon material.

5. C-horizon material should be targeted for higher density soil sampling programs because it is a proximal derivative of bedrock and is more homogeneous.

6. The flanks of valley bottoms may contain muck accumulations and should be avoided when soil sampling.

7. For all three of the deposit types investigated, the highest geochemical concentrations for Au, Pb, Zn and Cu were obtained most commonly from the -80 mesh fraction.

8. Analysis of a composite crush of soil material may be more susceptible to nugget effects when analyzing for gold. Overall, geochemical analyses of the composite crush returned lower values compared to results from the -80 mesh and -230 mesh fractions.

Acknowledgements

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